Observations of an Inward Breaking Filament During PAVE

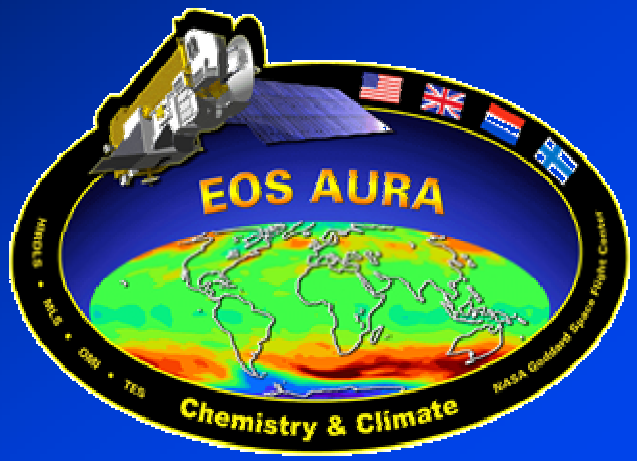
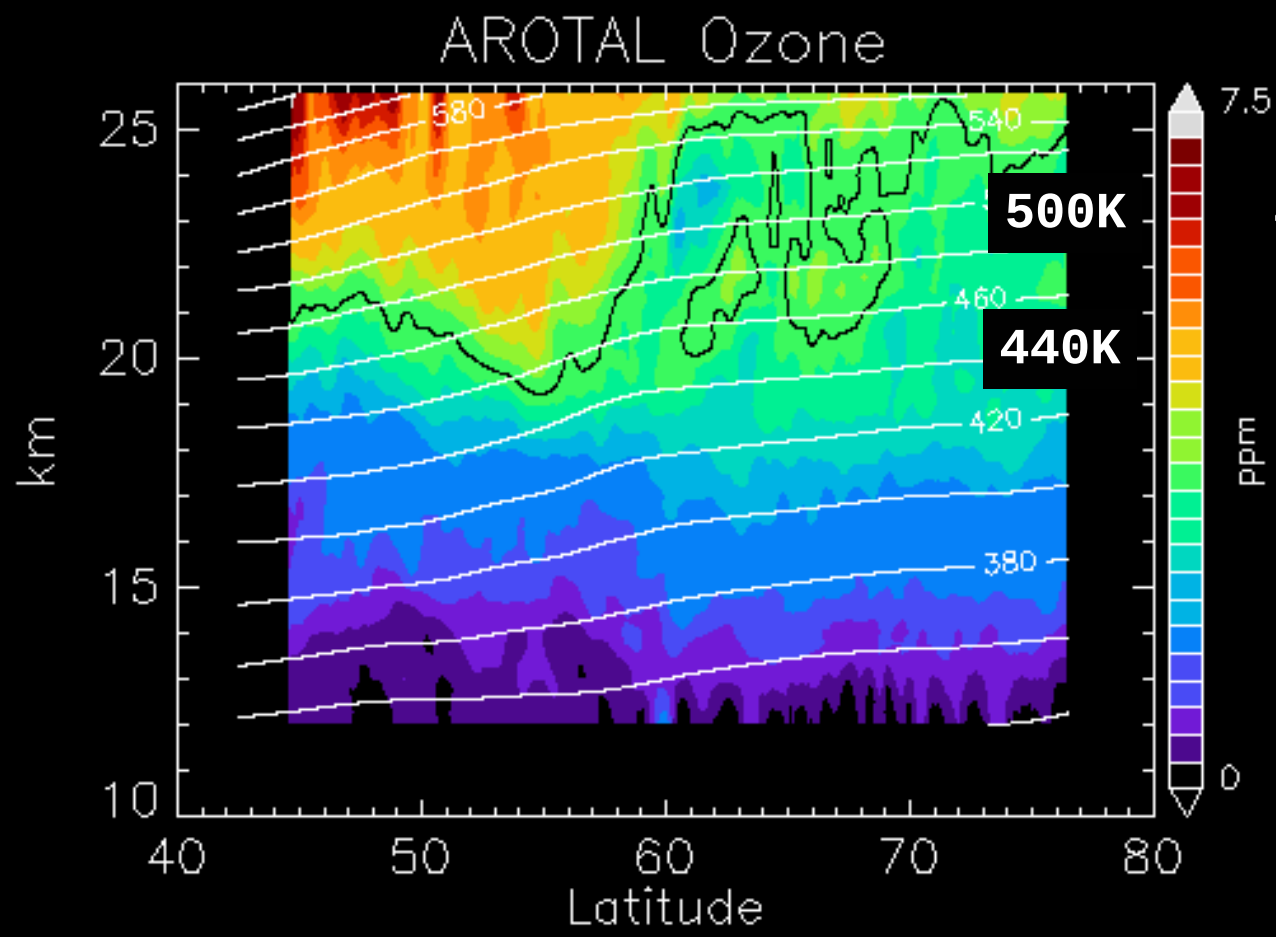


Photo by Mark Kroon

M. Schoeberl, T. McGee, A. Douglass, R. Kawa, E. Browell, L. Twigg, J. Waters & the MLS Team

One NASA

Observations Jan 31, 2005



AROTAL sees high ozone intrusions at 440 and ~500K

Black line is 3 ppmv

Vortex Filaments and Intrusions

- Most filaments are generated as the vortex erodes and thus are formed by "outward breaking" events
- However with strong localized ridging can produce "inward breaking" events can generate a vortex intrusion.

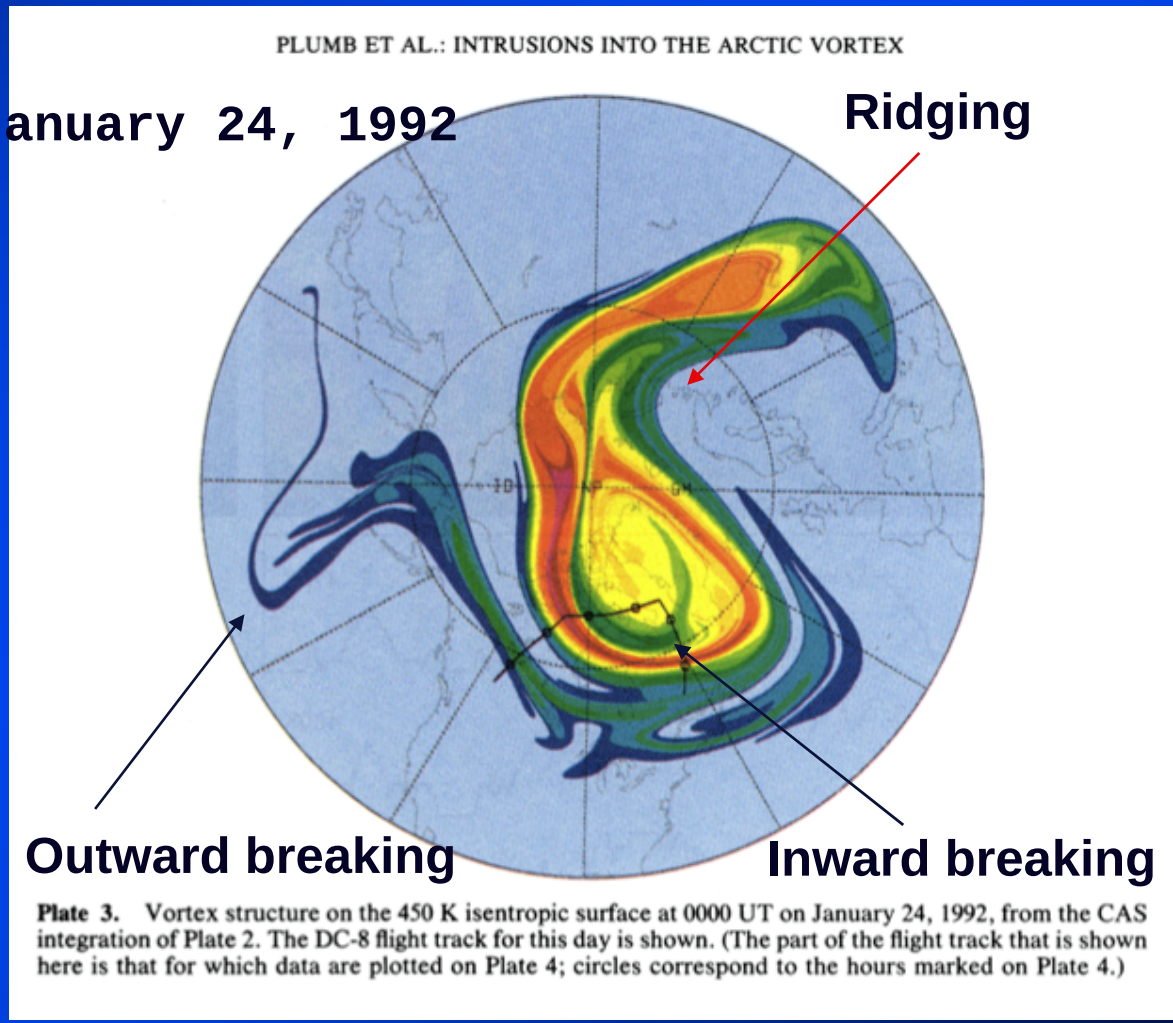
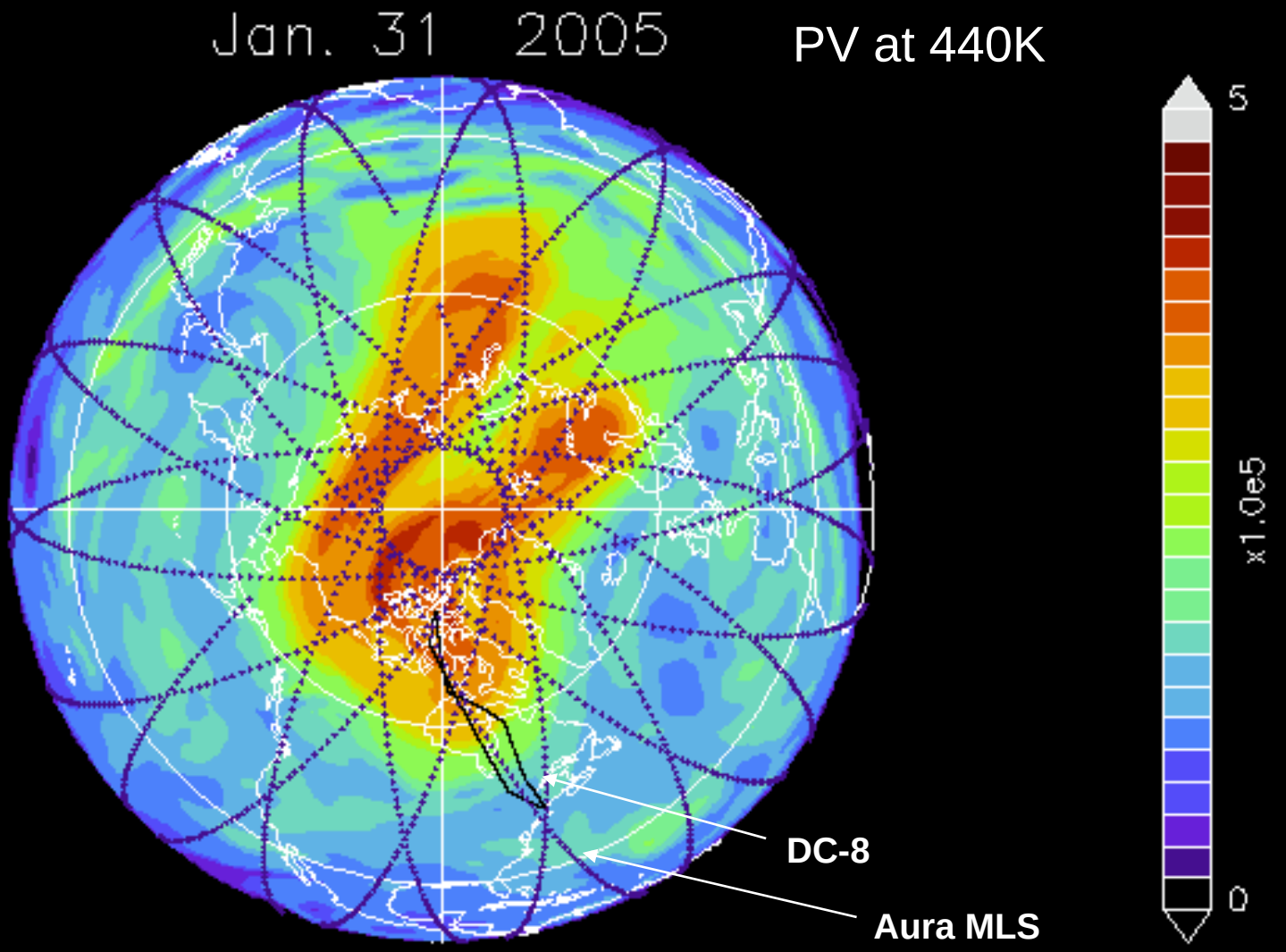


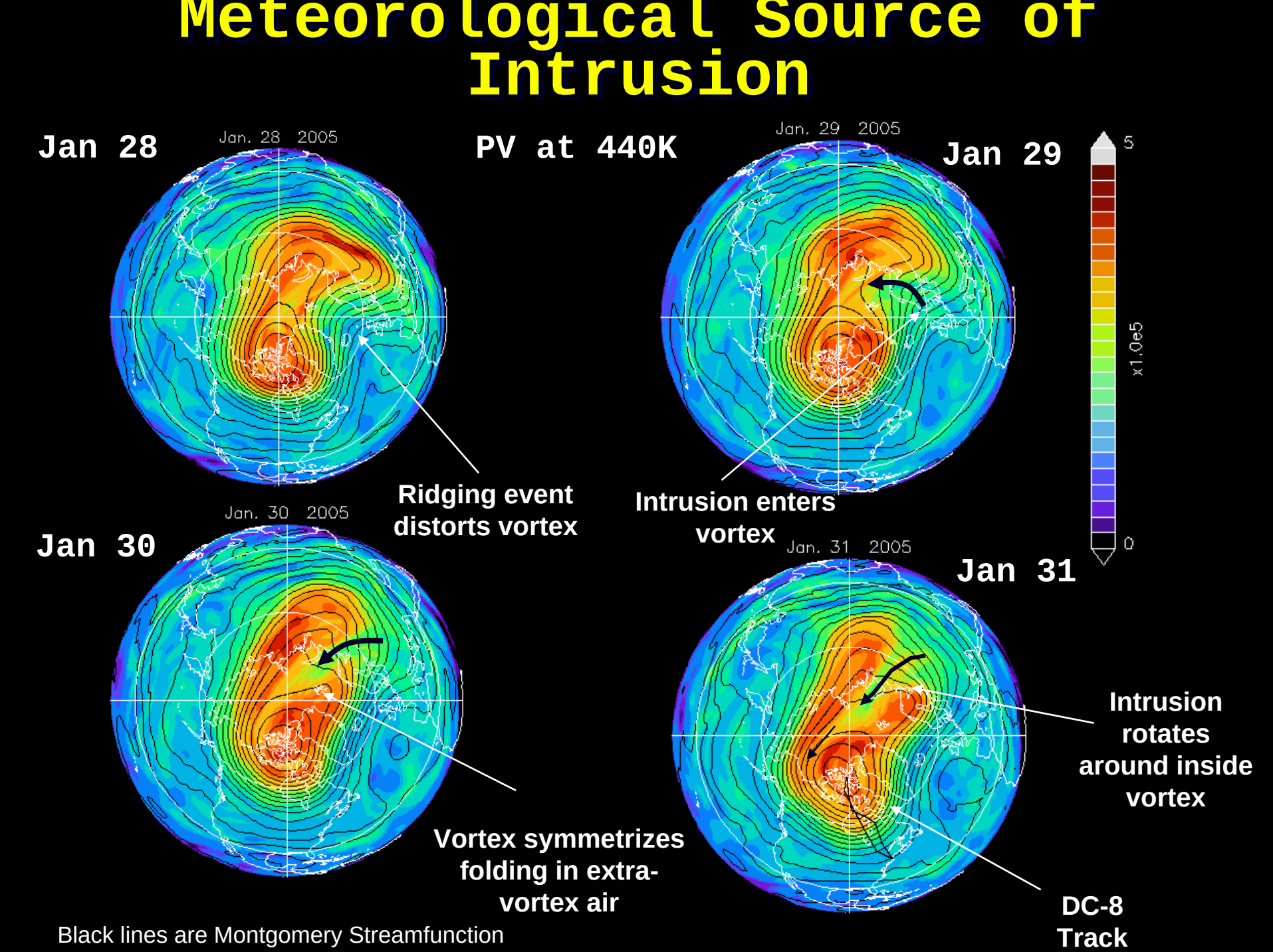
Plate 3. Vortex structure on the 450 K isentropic surface at 0000 UT on January 24, 1992, from the CAS integration of Plate 2. The DC-8 flight track for this day is shown. (The part of the flight track that is shown here is that for which data are plotted on Plate 4; circles correspond to the hours marked on Plate 4.)

An inward breaking filament was observed on the DC-8 Flight of Jan 31, 2005

Satellite and DC-8 Tracks



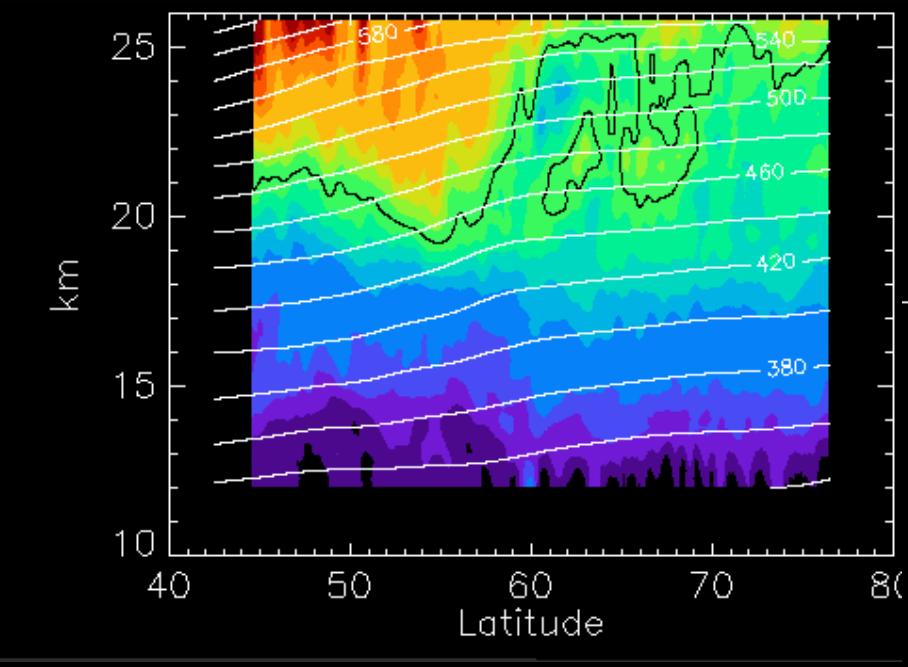
Meteorological Source of Intrusion



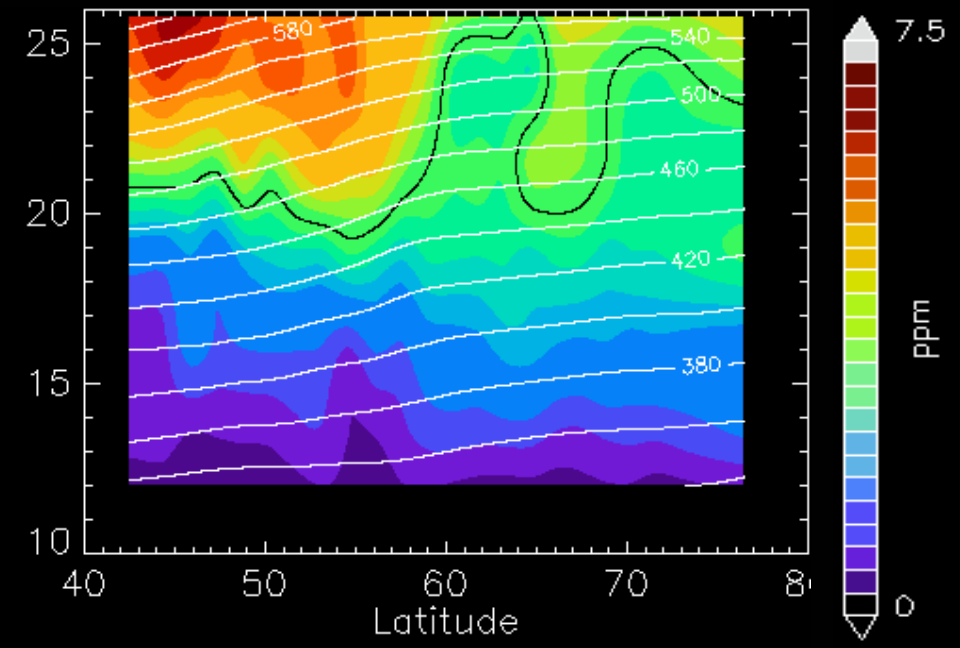
Black lines are Montgomery Streamfunction

AROTAL and MLS (O_3)

AROTAL



MLS

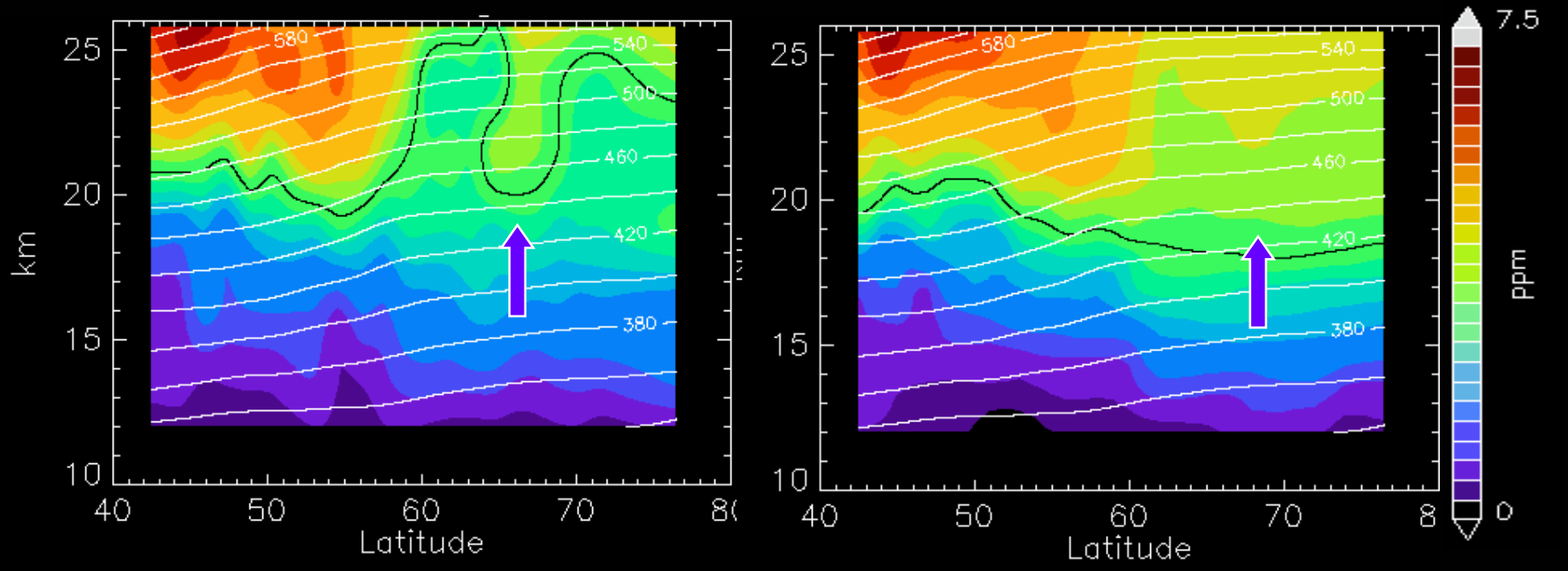


MLS Ozone compares well with AROTAL
Ozone outside the vortex is higher than inside.

Model and MLS (O_3)

MLS

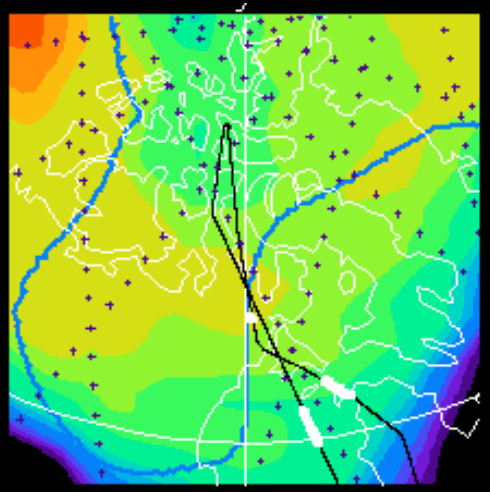
GSFC CTM using assimilated winds



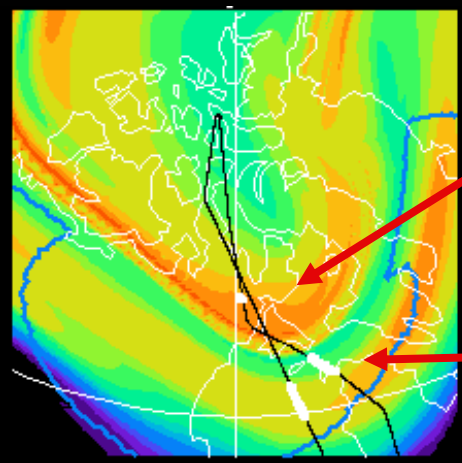
Model ozone captures a hint of the filament.

RDF Simulations (O_3)

MLS Ozone Map

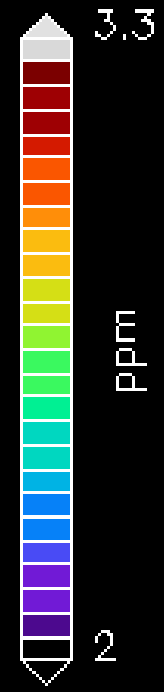


2 day RDF



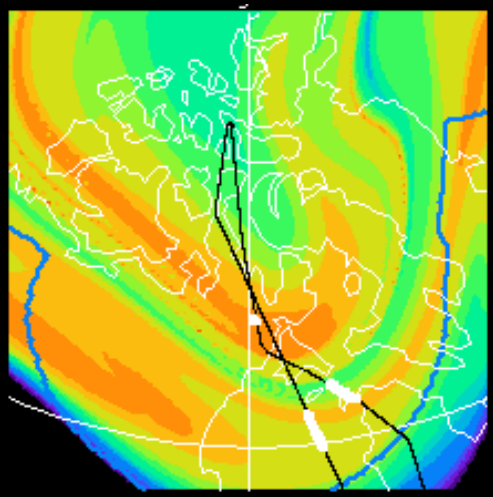
Intrusion

DIAL PSCs

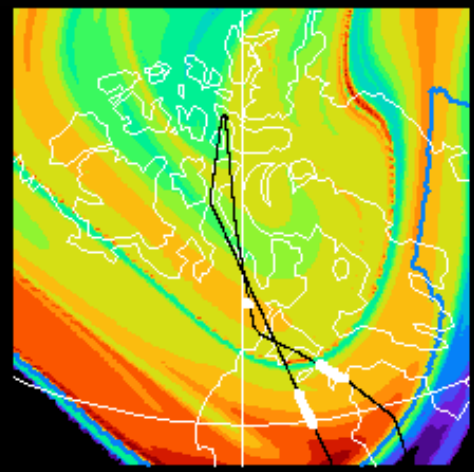


440K

4 day

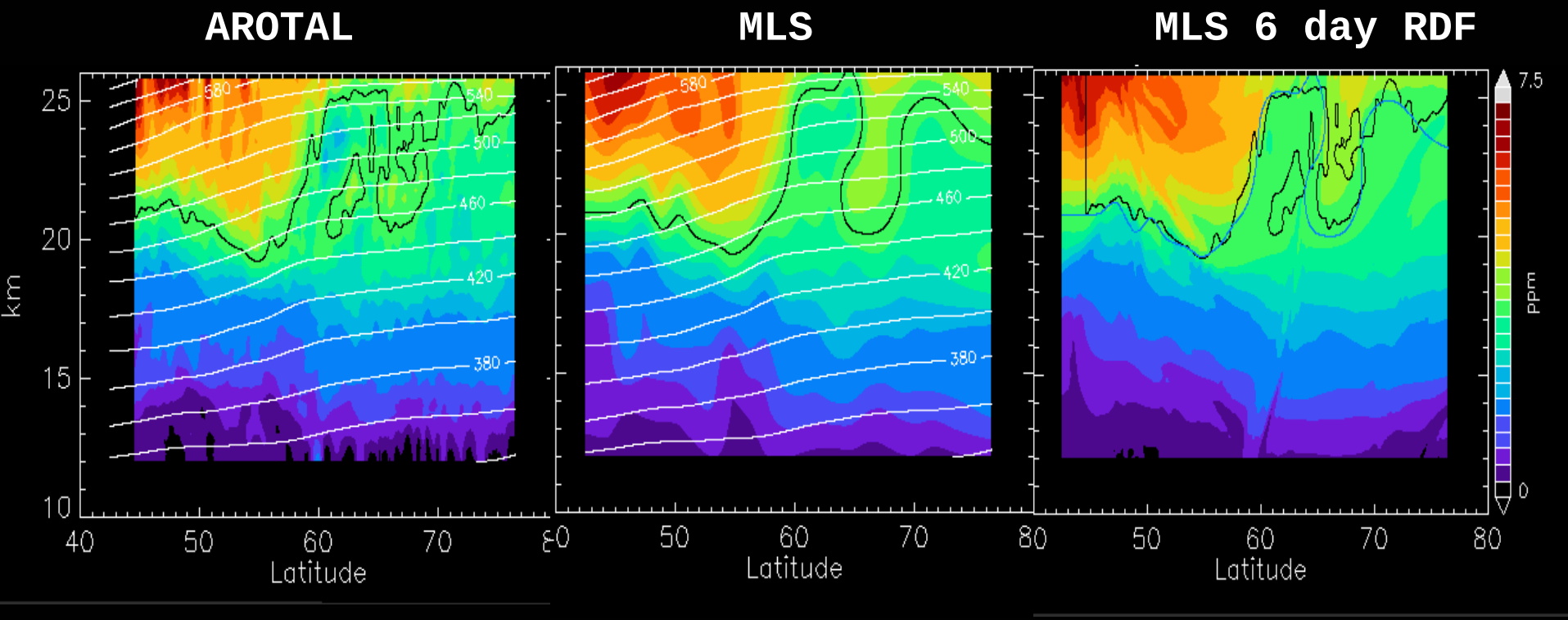


6 day



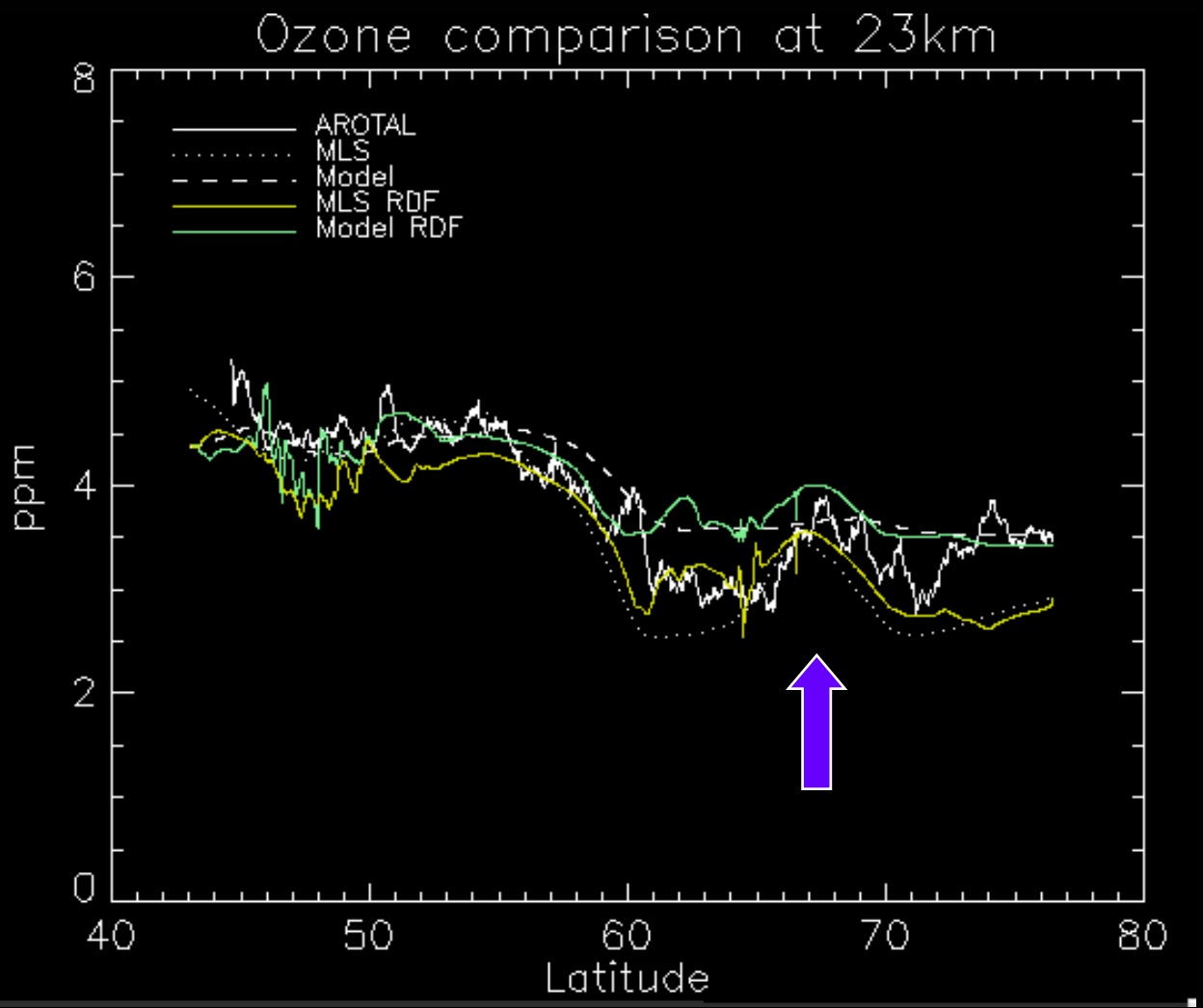
O_3 RDF's created using MLS maps of ozone from the previous days

AROTAL and MLS RDF



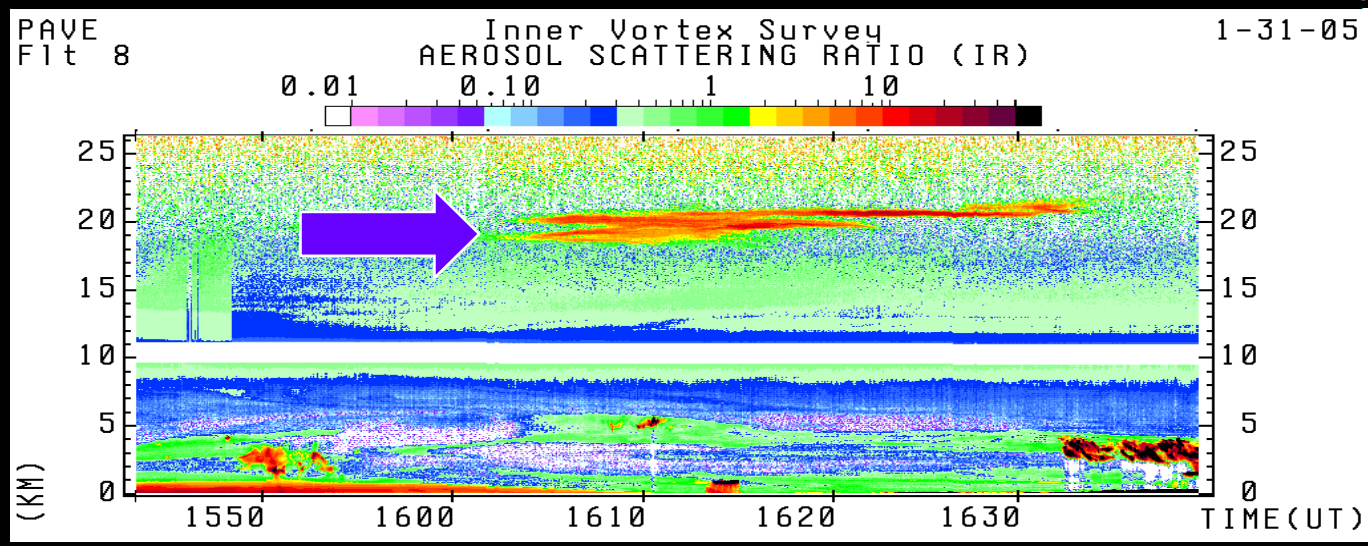
MLS RDF (using data from Jan 25, 2005) reproduces the structure showing that filament has dynamical origin

AROTAL and MLS RDF



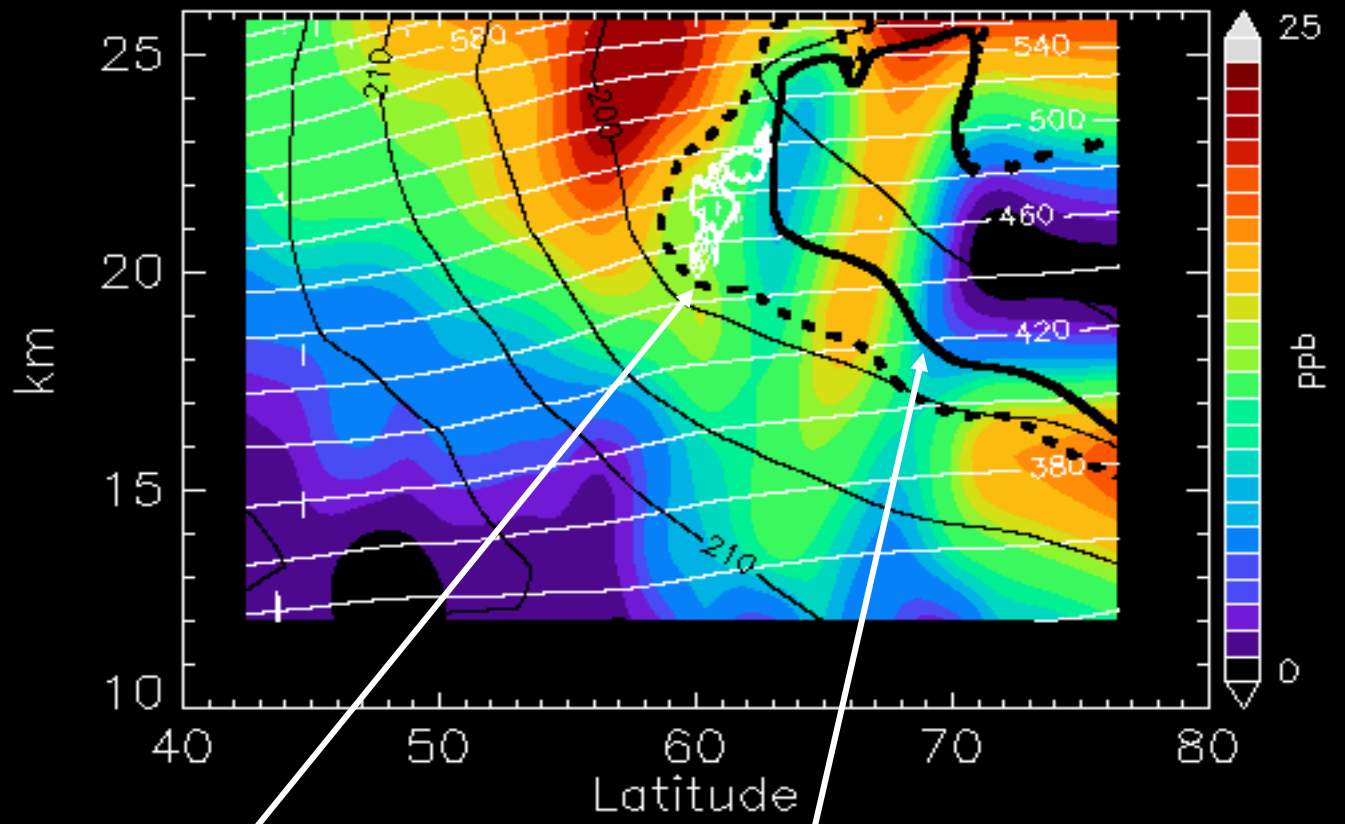
Filament is reproduced at 23 km

PSC's



NAT from DIAL ~20 km (440K)

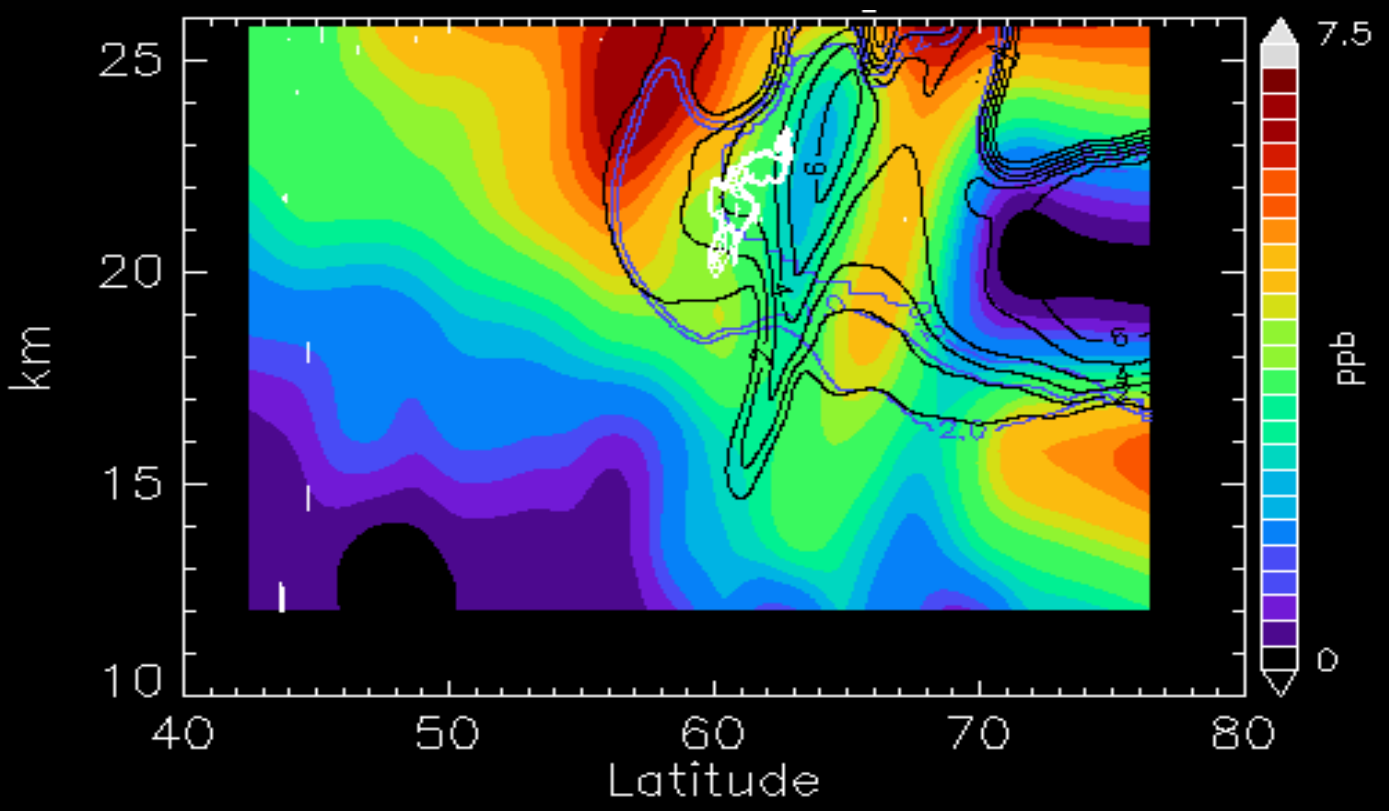
MLS HNO_3



DIAL PSC

T < NAT T using MLS N2O to define NOY* and H_2O

MLS HNO_3

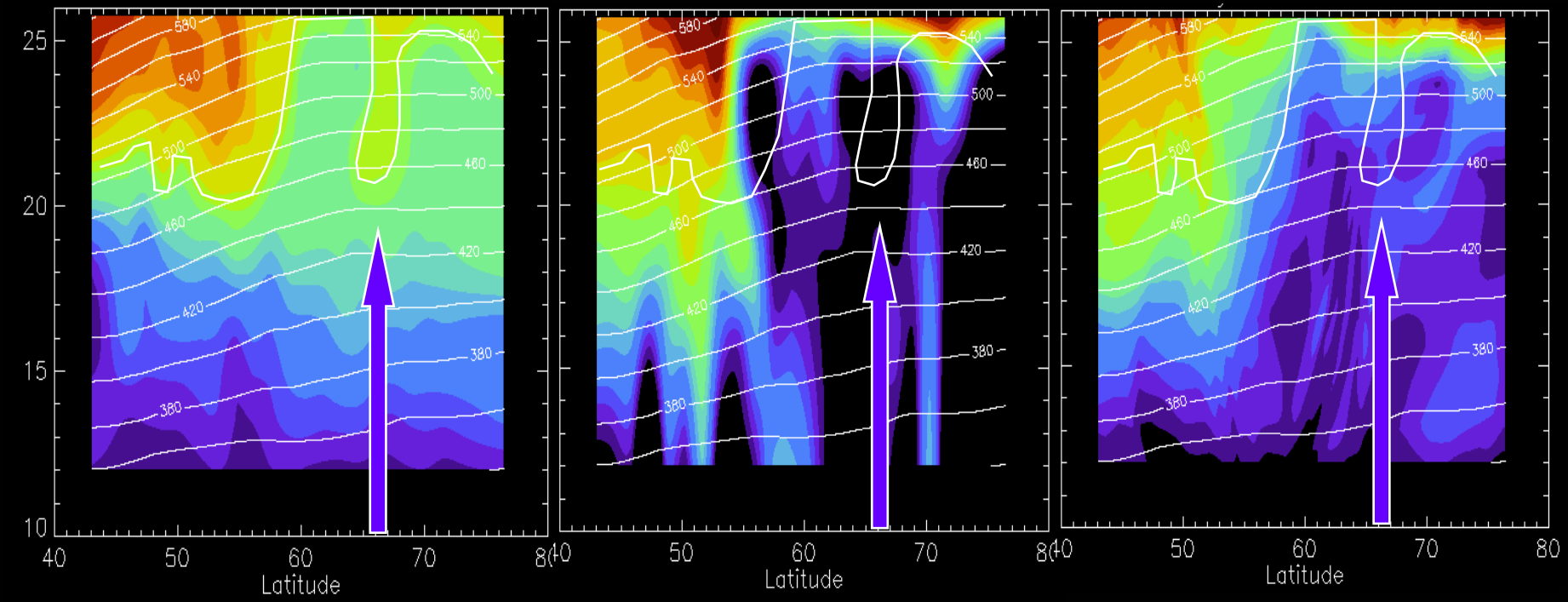


Black contours - exposure time to PSC condensation temperatures (days) from back trajectories.

Blue contours - “recent-ness” of PSC exposure

HCl RDF along MLS Track

MLS O_3 | MLS HCl | 2 Day HCl RDF



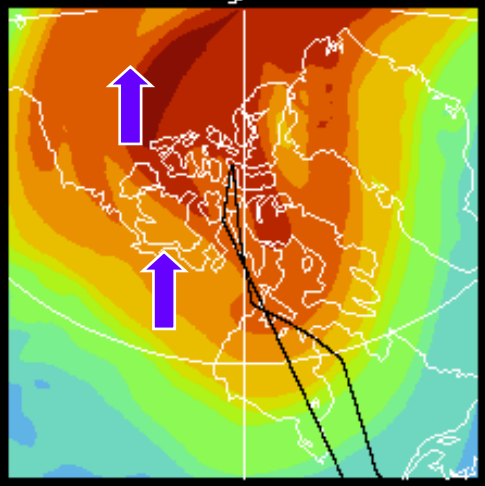
HCL shows no evidence of the filament suggesting that the filament air was processed. Also note vortex edge processing.

Summary

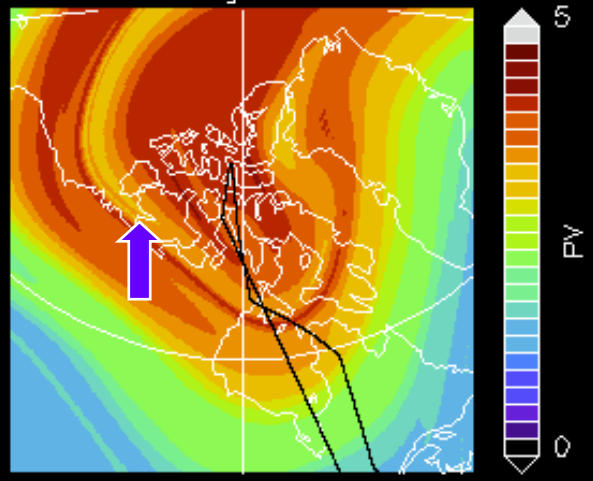
- AROTAL and MLS observed a vortex ozone anomaly on 01/31/05
- This anomaly is clearly an intrusion whose origin can be traced to a ridging event over Iceland
- MLS ozone RDF's improve the agreement with AROTAL demonstrating the dynamical nature of this event
  - The CTM shows a much weaker anomaly
- PSC's were also observed on this flight, the location of the northern edge of the PSC zone appears to coincide with a low HNO_3 band.
- MLS HCl measurements show no anomaly suggesting that the air was processed.

440K RDF Simulations (PV)

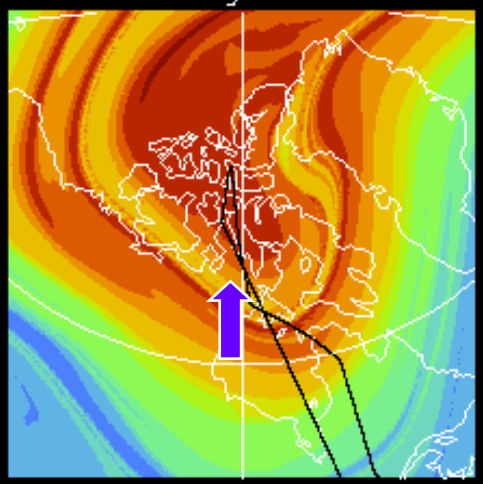
Analysis



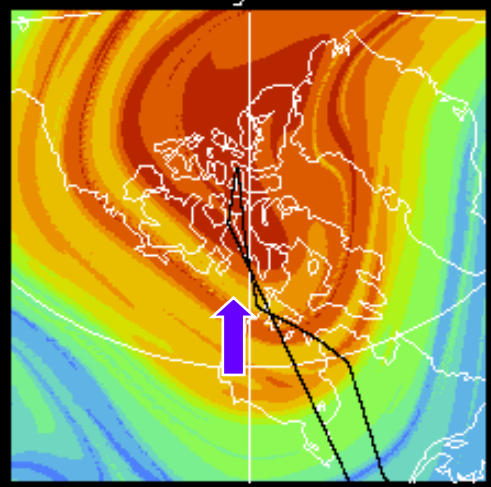
2 day



4 day



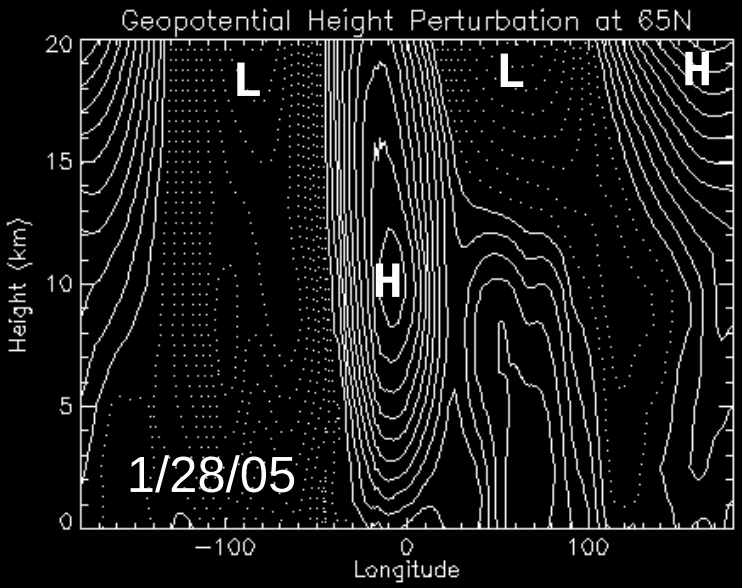
6 day

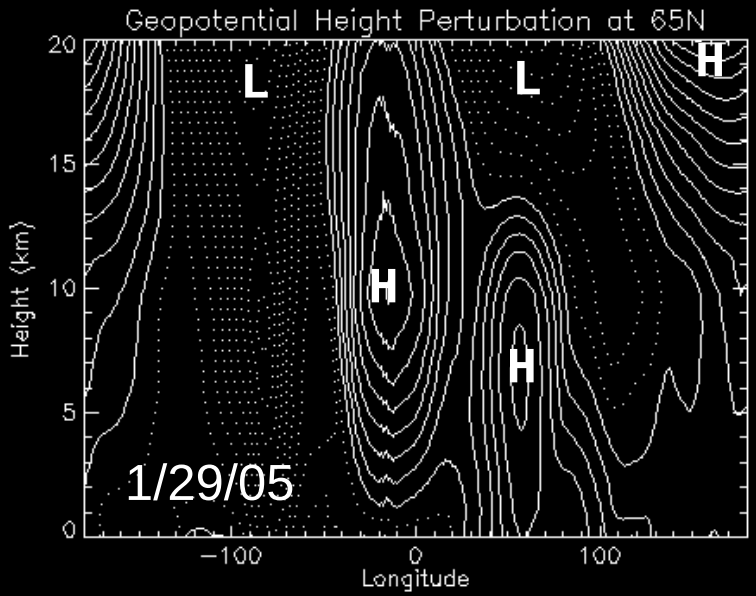


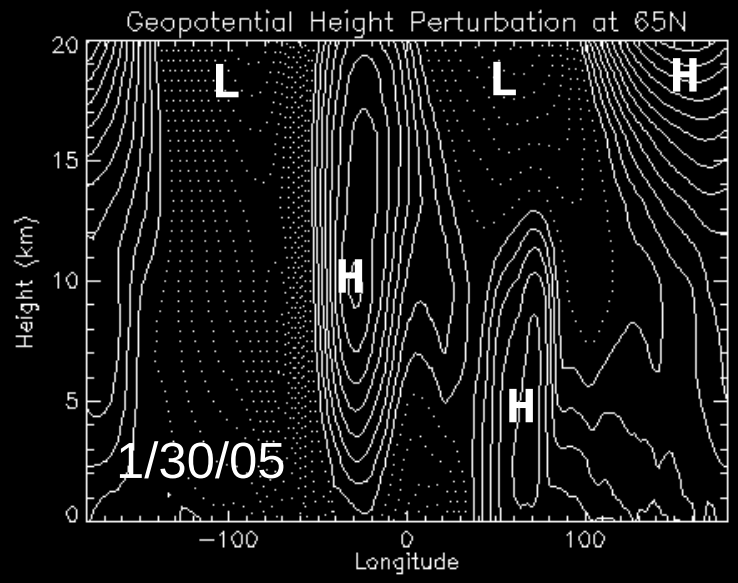
The RDFs show that the intrusion penetrates much more deeply than the analysis indicates. This intrusion is (low PV) and should be associated with high ozone. The 6 day RDF shows two low PV intrusions

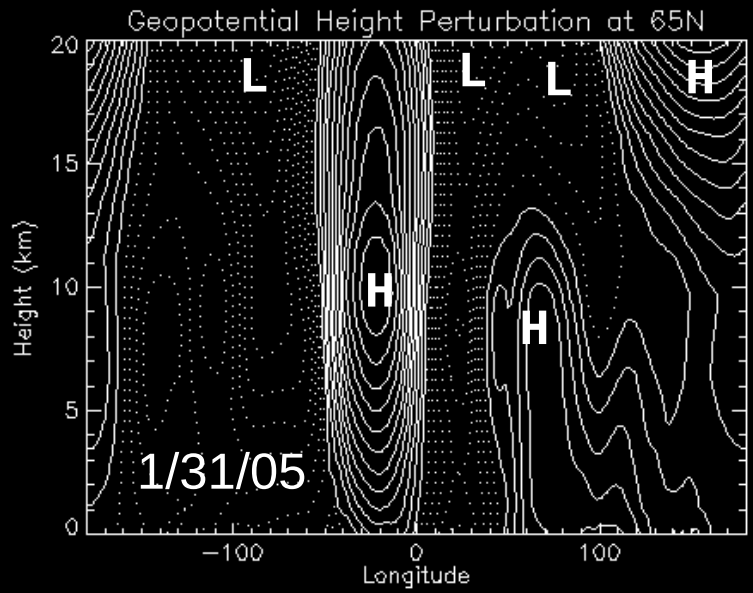
Variation of Blocking Ridge

Geopotential height perturbation at 65º N

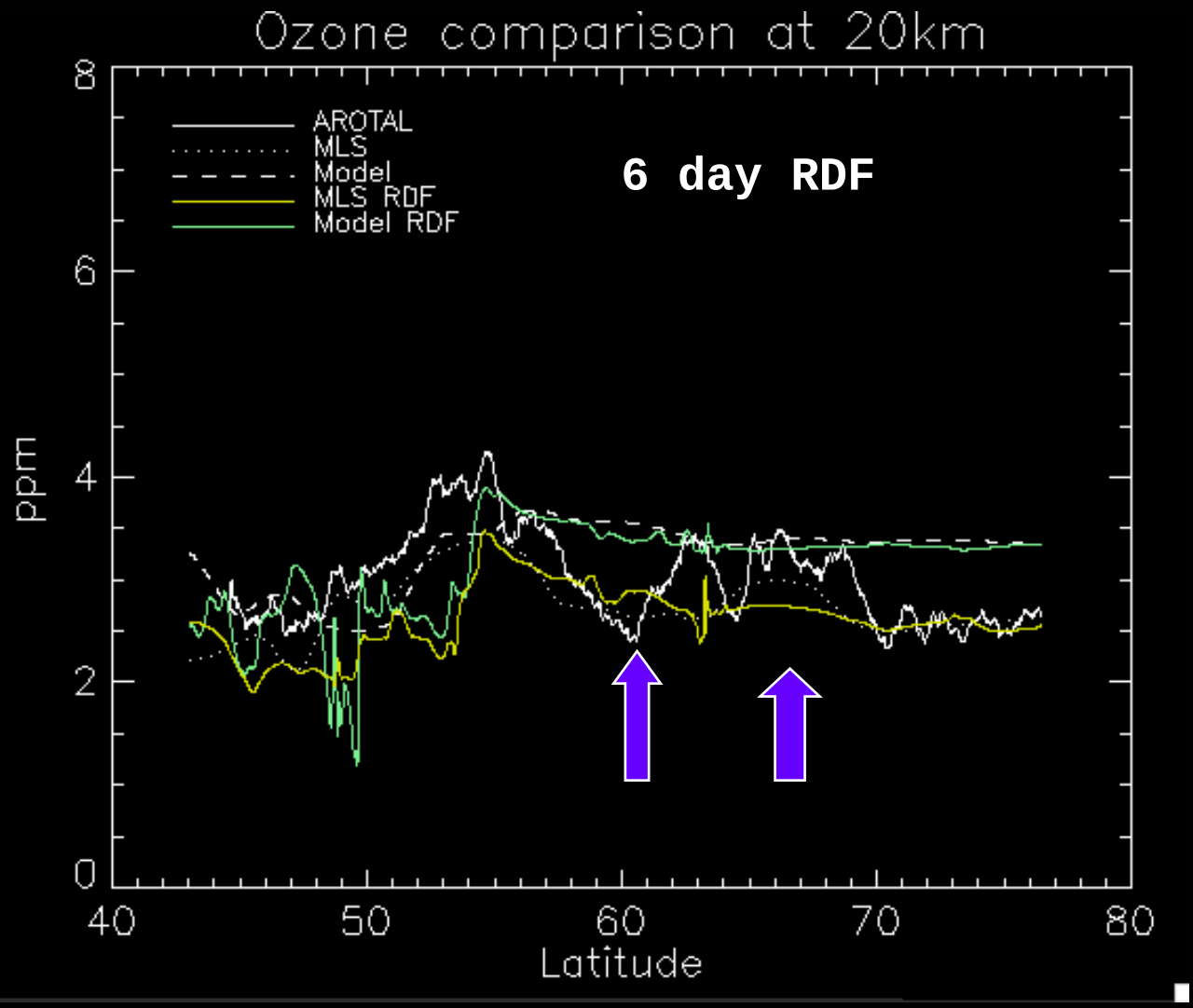








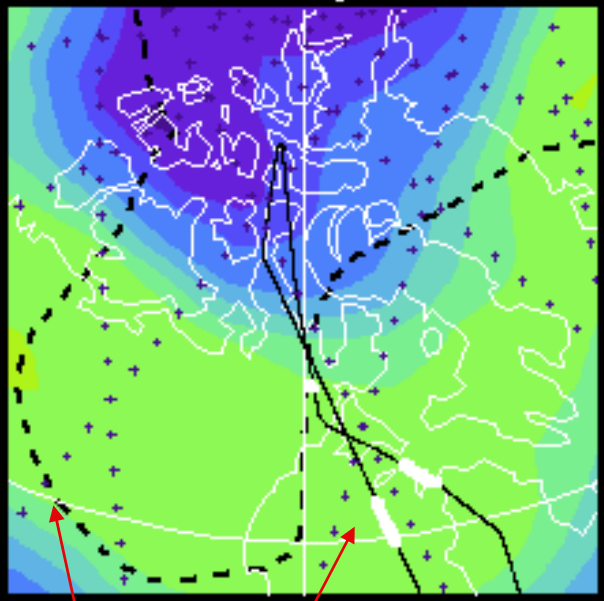
AROTAL and RDFs



Filament at 20 km is not well reproduced

HNO_3 RDF

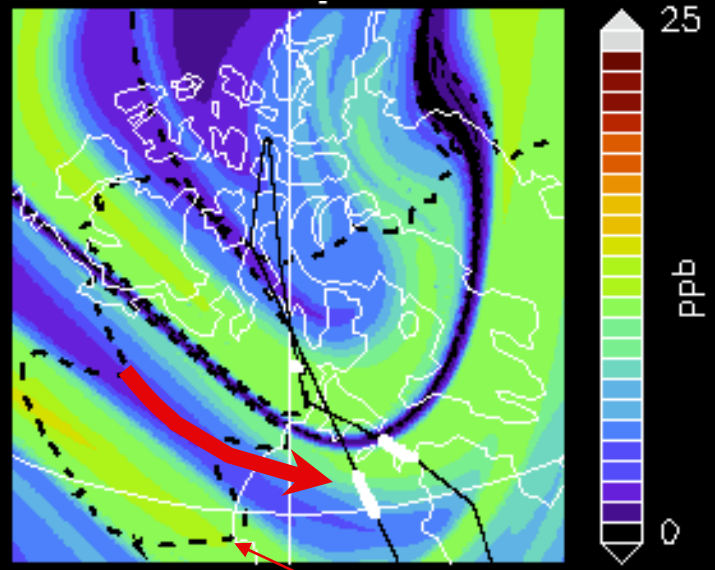
05/01/31



NAT Cloud observed by DIAL

NAT Temperature

6 Day RDF



RDF Parcels that have been at or below NAT temperatures

The edge of the NAT cloud corresponds to the filament edge.